CLAIMS:

1. A method of enhancing sound heard by a hearing-impaired listener, the method comprising

monitoring the sound in an environment in which the listener is located; and

manipulating the frequency of high frequency components of the sound in a high frequency band, with little, if any, distortion to components of the sound in a speech frequency band, to enhance spectral cues to aid the listener in sound externalisation and spatialisation.

2. The method of claim 1 which includes manipulating the frequency of the high frequency components by a technique selected from the group comprising: compressing the components across a frequency range, shifting the high frequency components to lower frequencies and combinations of the foregoing.

3. The method of claim 1 or claim 2 which includes

dividing the sound into a number of segments in time;

determining whether or not there are high frequency components of the sound in each of the segments; and

manipulating the frequency of the high frequency components only for segments in which there is an occurrence of high frequency energy above a predetermined threshold in the high frequency band.

4. The method of claim 1 or claim 2 which includes

dividing the sound into a number of segments in time;

determining whether or not the sound in each segment has a harmonic structure in the high frequency band; and

manipulating the frequency of the high frequency components only for segments in which there is little, if any, harmonic structure in the high frequency band.

5. The method of any one of the preceding claims which is implemented in at least one hearing aid of the listener, the method further including configuring the hearing aid to preserve acoustic filtering of an outer ear of the listener.

6. The method of any one of the preceding claims which includes determining a hearing range for the listener and customising the manipulation of the high frequency components to the hearing range of the listener.

7. The method of any one of the preceding claims which includes manipulating the high frequency components by first transforming a sound signal to the frequency domain and, thereafter, modifying the frequency domain representation using one of a mapping and a warping technique.

8. The method of any one of claims 1 to 6 which includes manipulating the high frequency components in the time-domain using at least one of a time-domain filter bank and a resampling technique to shift and/or compress the high frequency components to lower frequencies.

9. The method of claim 7 or claim 8 in which the mapping technique includes replacing frequency components in a range from f_1 to f_2 with frequency components in a second, lower range of f_3 to f_4 according to a mapping:

$$S\left(f_1+(f-f_3)\frac{f_2-f_1}{f_4-f_3}\right)\rightarrow S(f), \text{ where } f_3 \le f \le f_4.$$

10. The method of any one of the preceding claims which includes, when effecting the manipulation of the high frequency components, at least partially preserving a harmonic relationship between the components.

11. The method of any one of claims 1 to 8 which includes manipulating the high frequency components using a logarithmic compression technique.

12. The method of claim 7 or claim 8 which includes dividing the sound signal into a number of discrete frequency components and obtaining frequency components f_i above the speech frequency band for an output signal according to a mapping:

$$S(f_{n*i+c})\rightarrow S(f_i),$$

where n is a positive integer and c is a constant integer.

13. The method of claim 7 or claim 8 which includes dividing the sound signal into a number of discrete frequency components and obtaining frequency components f_i above the speech frequency band for an output signal according to a mapping:

$$S(f_{n*i+ci})\rightarrow S(f_i),$$

where n is a positive integer and c_i is adjusted for each i to select that frequency component with maximum energy out of frequency components f_{n*i} to $f_{(n+1)*i-1}$.

14. The method of claim 7 or claim 8 which includes performing frequency transposition of the sound signal using a Laguerre transform.

15. The method of any one of the preceding claims which includes further manipulating the frequency of the high frequency components by signal amplification.

16. The method of claim 15 which includes applying the signal amplification so as to maintain consistent relative gain across frequency for the high frequency components.

17. The method of claim 15 or claim 16 which is implemented using a hearing aid in each ear of the listener, the method including applying the signal amplification so as to maintain consistent relative gain between the two ears for the high frequency band of each ear.

18. The method of any one of the preceding claims which includes changing the relative amplitude of each frequency component of the sound independently before and/or after manipulation of the high frequency components.

19. The method of any one of the preceding claims which includes enabling the listener to discontinue manipulation of the high frequency components.

20. The method of any one of the preceding claims which includes

receiving auxiliary audio signals to be rendered as virtual audio; and

incorporating the auxiliary audio signals to produce an output audio signal including a virtual audio component.

21. The method of claim 20 which includes processing the auxiliary audio signals using virtual audio space techniques to create an effect for the listener that the sound originate at specific locations in a personal auditory space around the listener's head.

22. Equipment for enhancing sound heard by a hearing-impaired listener, the equipment comprising

at least one hearing aid device comprising:

a housing to be associated with an ear of the listener;

a sensor associated with the housing for sensing the sound;

a delivery medium carried by the housing for delivering processed sound to an auditory system of the listener;

a primary signal processing arrangement contained within the housing, the primary signal processing arrangement being configured to perform conventional hearing aid signal processing; and

an auxiliary signal processing arrangement in communication with the primary signal processing arrangement, the auxiliary signal processing arrangement being configured to manipulate the frequency of the high frequency components with little, if any, distortion to components of the sound in a speech frequency band to enhance spectral cues to aid the listener in sound externalisation and spatialisation.

23. The equipment of claim 22 which includes a listener operable interface for enabling the listener to disable the auxiliary signal processing arrangement.

24. The equipment of claim 22 or claim 23 which includes a discriminator in communication with the auxiliary signal processing arrangement, the discriminator discriminating between the frequencies of the components of the sounds and being operable to activate the auxiliary signal processing arrangement only for time windows in which there is an occurrence of high frequency energy above a predetermined threshold in the high frequency band.

25. The equipment of any one of claims 22 to 24 in which the housing is configured to minimally disrupt acoustic filtering of an outer ear of the listener.

26. The equipment of any one of claims 22 to 25 in which the auxiliary signal processing arrangement manipulates the high frequency components by at least one of compressing the high frequency components across a frequency range and shifting the high frequency to lower frequencies.

27. The equipment of claim 26 in which at least one of the primary signal processing arrangement and the auxiliary signal processing arrangement is further operable to manipulate the high frequency components by signal amplification.

28. The equipment of any one of claims 22 to 27 in which the auxiliary signal processing arrangement is interposed between the primary signal processing arrangement and the sensor.

29. The equipment of any one of claims 22 to 28 which includes two hearing aid devices, one for each ear of the listener.

30. The equipment of claim 29 in which the signal processing arrangements of each of the hearing aid devices are operable to amplify the high frequency sound components so as to maintain consistent gain between the two ears of the listener for each high frequency band.

31. The equipment of any one of claims 22 to 30 which includes a communications receiver in communication with the primary signal processing arrangement, the receiver receiving auxiliary audio signals to be rendered as virtual audio to produce an output audio signal including a virtual audio component.

32. The equipment of claim 31 in which the primary processing arrangement is operable to process the auxiliary audio signals using virtual audio space techniques to create an effect for the listener that the sound originates at specific locations in a personal auditory space around the listener's head.